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Backgrounder

CANADIAN SCIENCE POLICY: DEVELOPMENTS AND TRENDS

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INTRODUCTION

Controversy over science policy in Canada has been ongoing for many years and shows no signs of abating. Despite a great deal of discussion and repeated initiatives by government, the amount of research and development in this country remains very low. The growing importance of science and technology in the world today, however, makes imperative an examination of ways and means of improving Canada's weak record in this area. In order to understand more fully the problems of formulating a national science policy, this paper will outline the history of science in Canada, the central questions debated over the past three decades, and the issues under discussion today.

UNESCO has defined science policy as "the sum of the legislative and executive measures taken to increase, organize and use the national scientific and technological potential, with the object of achieving the country's overall development needs and enhancing its position in the world."(1) One criticism of this definition is its implication that government should be involved in the organization of scientific activities. Many in the scientific community feel that more freedom, and less restrictive management, is what is needed to perform new, innovative scientific research. Since government is one of the significant participants in scientific funding in Canada, however, it must inevitably be deeply involved. As a general guide, some scientists have suggested

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(1) Quoted in "A Science Policy for Canada," Report of the Senate Special Committee on Science Policy, Vol. 1, Ottawa, 1970, p. 2.

that the science policy of the Canadian government should help to establish a climate in which scientific research and development is actively encouraged.

The main players involved in Canada's science policy debate are the universities, government and industry. Arguments erupt over both who should pay for the research and who should perform it, but there is general agreement that not nearly enough research and development is carried out in Canada at present. In order to understand this complex debate, it is necessary first to examine the growth of science in this country.

BACKGROUND

Canada's scientific roots lie with natural resources. Early scientific investigation centred on mineral resources, forests, agriculture, fisheries, and biology, and it was to manage these areas that the oldest scientific departments of the government were founded. Until the First World War, the Canadian government concentrated its scientific activities on natural resources. In a country with a small population and large territory, this was a sensible approach.

In 1917, in the middle of the First World War, the National Research Council (NRC) was created with the mandate to coordinate scientific and industrial research in Canada. Although set up as an advisory council, throughout the 1930s the NRC constructed laboratories and began to establish itself as a central player in scientific and industrial research.(2)

The National Research Council expanded enormously from 1939 to 1945 as it became increasingly taken up with different aspects of war work. Starting at the beginning of the war with a total staff of 300, it

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(2) For documentary information on the early days of the National Research Council, see Mel Thistle, The Inner Ring, Toronto, 1966, and Wilfrid Eggleston, National Research in Canada, Toronto, 1978.

rapidly expanded and within a few months had grown to 2,000.(3) By the end of the war, from an advisory council the NRC had become a large research establishment and the central scientific institution in Canada. There was still, however, some confusion about its role. Thus, despite the growing success of NRC scientists, there remained in the postwar years a void in the science policy-making machinery.

THE GLASSCO COMMISSION

The question of a science policy for Canada was raised in the January 1963 report of the Glassco Commission on government organization, one section of which examined postwar scientific research and development. It looked not only at the National Research Council but also at other scientific activity in Canada. The postwar years had seen a growth in government involvement, with the formation of new scientific agencies and increased scientific activity in various government departments. Despite this growth, government expenditures on research and development (R&D) remained low, amounting in 1959 to only three-quarters of 1% of the gross national product.

The Glassco Commission criticized the lack of funds being directed towards research and development, but it also attacked the organization of postwar government science activity, arguing that expansion had proceeded "on a piecemeal basis without adequate coordination."(4)

The Glassco Commission indicated that changes were needed but, for specific recommendations on what actions to take, Prime Minister Pearson turned to former National Research Council president C.J. Mackenzie. In his ensuing report, Mackenzie recommended that a central scientific bureau be established in the Prime Minister's office. He

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(3) "A Science Policy for Canada," Report of the Senate Special Committee on Science Policy, Ottawa, 1970, p. 61.

(4) The Royal Commission on Government Organization (Glassco Commission), Vol. 4, Ottawa, 1963, p. 218.

accepted the Glassco recommendation for creation of a secretariat and an advisory council but advised against their interfering with the functioning of existing government agencies.(5)

The Pearson government acted quickly on Mackenzie's recommendations. On 30 April 1964, it announced that a Science Secretariat would be formed as part of the Privy Council Office. Its role would be "to assemble and analyze information about the government's scientific programs and their interrelation with other scientific activities throughout Canada."(6) Further, in 1966, the Science Council was created. Its function was to define long-term objectives for science in Canada. It would be an advisory body only, with no authority over expenditures or government department budgets. In 1968 it became a Crown corporation able to hire its own staff.

Despite these initiatives, the debate on science policy in Canada continued. In 1967 the Senate of Canada decided to launch a special investigation of science policy in Canada. In part, this decision stemmed from an ongoing controversy that centred on two large scientific projects first proposed earlier in the decade. Both projects were cancelled by the new Trudeau government in the fall of 1968.

THE LAMONTAGNE COMMITTEE

Under the chairmanship of Senator Maurice Lamontagne, the Senate committee made an extensive examination of the history of science in Canada and in 1970 issued a list of recommendations, which called for an overall science policy. Although the report agreed that science policies also had to be established sectorally, it stressed the need for an overarching structural framework. The report argued that, in the past, Canadian science policies had accentuated the role of government and

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(5) G. Bruce Doern, Science and Politics in Canada, McGill-Queen's University Press, Montreal, 1972, p. 8-9.

(6) Ibid., p. 10.

university science in the hope that this would promote industrial research and development. This had failed to happen. Committee members called for a policy which would encourage industrial innovation and contribute solutions to social problems.

The report was also critical of the amount of research and development carried out by government and universities rather than by industry. It suggested that three foundations be created to allocate basic research funds in the life sciences, physical sciences and social sciences. The Medical Research Council (1969) and the Natural Sciences and Engineering Research Council (1978) were formed from units already existing within the NRC. The Social Sciences and Humanities Research Council (1978) had previously been part of the Canada Council. At the same time, the report said that industry should take control of a high proportion of development and stressed the need to improve high-technology industries.

LIBERAL INITIATIVES DURING THE 1970s

A number of the recommendations of the Lamontagne committee were acted upon throughout the 1970s. In 1971 the Trudeau government appointed a Minister of State for Science and Technology who would have no departmental responsibilities and would preside over a small secretariat. The ministry had broad terms of reference and was made responsible for the overall formulation of policy and coordination of activity in the area of science and technology.

The formation of a Ministry of State was viewed as a step in the right direction but since the new ministry had little power at the Cabinet table, science and technology questions continued to receive little attention from the federal government. A number of programs were established to encourage research and development but they did not have much impact. Some tax incentives were put in place to encourage investment in this area but few were there long enough for their effectiveness to be judged.

By the time the Conservatives came to power in 1984, little had improved in the science and technology world in Canada. No clear science policy was in place and the piecemeal efforts by the government were arguably causing more harm than good. As one author has noted, since the 1960s Canada had achieved what could be better described as "policy anarchy" rather than science policy.(7) Despite the existence of a Ministry of State for Science and Technology, few changes had been implemented. Short-term tax incentives, including the politically damaging Scientific Research Tax Credits, had not increased the amount of R&D in Canada. Despite the discussions of the 1960s and 1970s, a successful science policy had not yet emerged.

CONSERVATIVE INITIATIVES SINCE 1984

In September 1984 the Progressive Conservatives came to power with a large majority. In the five years since then, the government has initiated programs and strategies dealing with science and technology. Although it is still early to judge the effectiveness of many of these programs, it is useful to examine them to see if significant changes have occurred so far.

During the 1984 election campaign the Conservatives emphasized that increased spending on research and development was vital to Canada's future economic well-being. Much of this increase, it was suggested, should come from private sector spending but it was recognized that support from government would also be necessary.

After the election, it was soon apparent that the highest priority on the government agenda was to reduce the deficit. A task force on program review recommended budget reductions for the National Research Council and the Science Council. The Science Council was especially hard hard-hit, learning, in the summer of 1985, that both its budget and staff

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(7) William Leiss, "Policy Anarchy," Science and Public Policy, Vol. 15, No. 1, February 1988, p. 58.

would be halved over the following two years. Many in the scientific community felt that these cuts were unfair and detrimental to science in Canada.

Despite this disappointing start, later in their first mandate the Conservatives did take a number of initiatives in the science and technology areas. They approached the question of a national science policy in consultation with the science ministers from the provinces and two territories and in March 1987, the federal, provincial and territorial science ministers signed Canada's first National Science and Technology Policy.(8)

The National Science and Technology Policy is meant to "bring science and technology to bear on the economic, social, cultural and regional development of the country by encouraging cooperation among governments and between public, quasi-public and private sectors."(9) It defines six major objectives to be reached through cooperation among government, industry, universities and labour. They are to:

- improve industrial innovation and technology diffusion through public and private mechanisms;
- develop strategic technologies for manufacturing, service and resource-based sectors;
- assure the necessary pool of highly qualified people;
- support basic and applied research and development;
- control the impact of technological change on society; and
- promote a more science-oriented culture.(10)

Discussions surrounding the adoption of these goals stressed the growing importance of science and technology in today's global

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(8) Paul Dufour and Yves Gingras, "National Policy-Making," Science and Public Policy, Vol. 15, No. 1, February 1988, p. 13-18.

(9) "The National Science and Technology Policy, Background Paper," Ottawa, 1985.

(10) Ibid., p. 6-9.

economy. It was agreed that Canada must take measures to improve its performance in this sector, or Canadians would suffer economically in the future. Further, Canada needed to move away from a resource-based economy towards one based on use of technology. A number of plans were put forward for discussion. Investigation into increasing private sector investment in R&D was suggested as was an examination of the use of science and technology to promote regional, provincial and territorial development. Means should be established to acquire technologies in the natural resource-based industries and a definite plan to increase research and development in Canada should be implemented. Canadian business could be made more competitive by having more information transferred from government and university laboratories to industries. The state of basic research should be examined and the training of qualified personnel improved. Finally, an evaluation of the social and cultural impact of technology is needed.

The next major initiative by the government was "InnovAction," its strategy for science and technology. The strategy is guided by four basic principles:

1. need for increased commitment by industry to science and technology;

2. need for increased cooperation between industry, labour, universities and government;

3. pursuit of research and development in the public interest; and

4. cooperation of industry, universities and government to acquire foreign technology.

Though the InnovAction document clearly defined the problems facing Canada in the science and technology area, overall it appeared that it was less helpful in outlining exactly what measures would be taken to alleviate them.

In August 1987, the government announced that a new department, Industry, Science and Technology Canada (ISTC), would be formed by joining the Department of Regional Industrial Expansion with the

Ministry of State for Science and Technology. The primary goals of ISTC are to improve Canadian industry's ability to compete in the international market and to achieve excellence in Canadian science and technology.

This was a welcome move. Many scientists had believed that science and technology could have little status as long as it was managed by a ministry of state. For many years it had been felt that the minister had little say in Cabinet and was unable to fight for the necessary funds. By creating a new department specifically to handle science and technology policy, it was hoped that the Prime Minister was giving this issue the attention it deserved.

The scientific community was also pleased when the Prime Minister announced the formation of a National Advisory Board on Science and Technology (NABST) in February 1987. Made up of members with industrial, governmental, labour, education and research backgrounds, this 35-member committee is a steering committee for the government's overall policies in the science and technology field. Furthermore, the Prime Minister is the chairman of this committee - a sign that he considers science and technology issues to be of great importance. Criticisms have been levelled at NABST. For example, the fact that the representatives have been chosen from university, labour and business circles, many of whose interests overlap, could make constructive action difficult in the future. Because the Committee has only been in existence for a short time, however, and because its reports are not made public until long after they are written, it is still difficult to judge its performance.

Another organizational change implemented in the last Parliament was the formation of a House of Commons Standing Committee on Research, Science and Technology. This Committee studied a number of topics related to science and technology, including the Canadian space program. In the present Parliament the Committee has taken on northern and regional development problems and is now called the House of Commons Standing Committee on Industry, Science and Technology, Regional and Northern Development. While it can be argued that this change better reflects the mandate of ISTC, it does mean that the effort that went into creating a separate committee with a science focus has been thwarted, only

three years after the Research, Science and Technology Committee was formed.

In January 1988, the Prime Minister confirmed his intention to improve Canadian science and technology with an announcement that the federal government would set $1.3 billion aside for science and technology programs. He stated that the universities would be the major focus for science and technology initiatives over the next five years. Some of the money would be used to create "centres of excellence" on campuses across the country. Groups were invited to put forward proposals which would then be judged by an independent jury of international experts (see discussion below, p. 15). Mr. Mulroney also focused on the need to encourage young people to continue their education in science fields. To make this possible, 2,500 undergraduate scholarships will be available to students in science and engineering. In March 1989, it became clear how the $1.3 billion would be divided. The majority of it ($525 million) will go toward the new department, Industry, Science and Technology Canada, for new programs and services. Space-related activities (including a contribution to the U.S. space station) will consume $255 million. The Centres of Excellence will account for $240 million, $200 million will go to the three granting councils, and the remaining $80 million will go to scholars. The money will be distributed over a five-year period but it is still not clear when the five-year period will begin or at what rate the money will be dispersed.

The most recent development came in September 1989 with the release of a document entitled The Halifax Declaration: A Call to Action. This lays out five broad issues where common action is needed as determined by Canada's 12 federal and provincial science and technology advisory councils. The first, and most important, goal concerns a national target for Canada's gross expenditures on research and development. The Declaration recommends that this be increased to 2.5% of the Gross Domestic Product (GDP) by the turn of the century. A second goal is promotion of national awareness; this might include a network to help improve coordination among federal and provincial activities but will also work to boost

public interest in science and technology. Education is the next item on the list, followed by the need to build up science-based industrial innovations. The final issue addressed is Canadian ownership of high tech enterprises. This will likely be hotly debated but it is hoped that domestic control of research-intensive businesses can be encouraged.

PRESENT SITUATION

In Canada today, the federal government is the largest single funder and performer of science and technology studies. In 1988-89, federal expenditures on science and technology will reach $4.4 billion. These expenditures, however, are not managed as an envelope within the Cabinet committee system. In fact, the federal science and technology effort is highly fragmented. In total, there are 77 programs and 53 organizations reporting to 25 different ministers. But it must be noted that of these, five departments and agencies account for 45% of the total science and technology budget.(11) With so many players involved, it is little wonder that a cohesive science policy is difficult to formulate.

A great deal of discussion takes place in Canada on the amount of money the federal government spends on research and development (R&D). This figure is usually quoted as a percentage of the GDP and is called the GERD (for Gross Expenditure on Research and Development). It is considered a crucial indicator of government performance in science and technology. Canada currently spends approximately 1.4% of its GDP on R&D, a smaller percentage than any other major industrialized nation. Another significant indicator, the proportion of scientists and engineers in the work force, also places Canada last of eight major industrialized nations.

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(11) These are: Agriculture, Energy, Mines and Resources, Environment, National Research Council and Natural Sciences and Engineering Research Council; figures cited above are from "Science and Technology Resource Allocation Statistics," Industry, Science and Technology Canada, 1989.

There are a number of other scientific indicators; sadly, Canada does not fare well in any of them (see Table 1).

Although these figures are indisputable, there is a great deal of disagreement over where to lay the blame. The government has been widely criticized for not spending enough money on R&D. This money is essential, many argue, both to provide a research base and to fund research that would not otherwise be undertaken because it is not immediately profitable. Further, the private sector says that the Canadian government must create an environment that encourages R&D spending. In Canada especially - a country known for its cautious investors - people must be actively encouraged to invest in projects that do not promise an immediate return.(12) What is not clear, however, is the sort of inducements for investment that should be put in place. After the disastrous Scientific Research Tax Credit scheme was cancelled in 1985, many in government are wary of investment schemes.

The government has responded to industry calls for greater federal R&D expenditures by pointing to industry's own record in that area. In August 1989, Mr. Mulroney complained that industry had failed to match government's support of R&D over the last few years. Noting that business has fared well under his Conservative government, Mr. Mulroney criticized business for not reinvesting some of its profits into R&D.(13)

Recent figures released by Statistics Canada, however, support industry's position in this debate. They indicate that "the business enterprise sector continues to grow in importance as a performer of R&D (55% of total) and as a funder (42%); the federal government continues to decline, both as a performer (17% of total R&D) and as a funder (31%)" (see Table 2).(14)

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(12) "Government and Companies Blame Each Other on Research and Development," Globe and Mail (Toronto), 22 May 1989.

(13) "Better Education, Scientific Research PM's Top Priorities," Globe and Mail (Toronto), 26 August 1989.

(14) Statistics Canada, Science Statistics, August 1989.

TABLE 1

Canada's R&D performance doesn't stack up too well against other nations

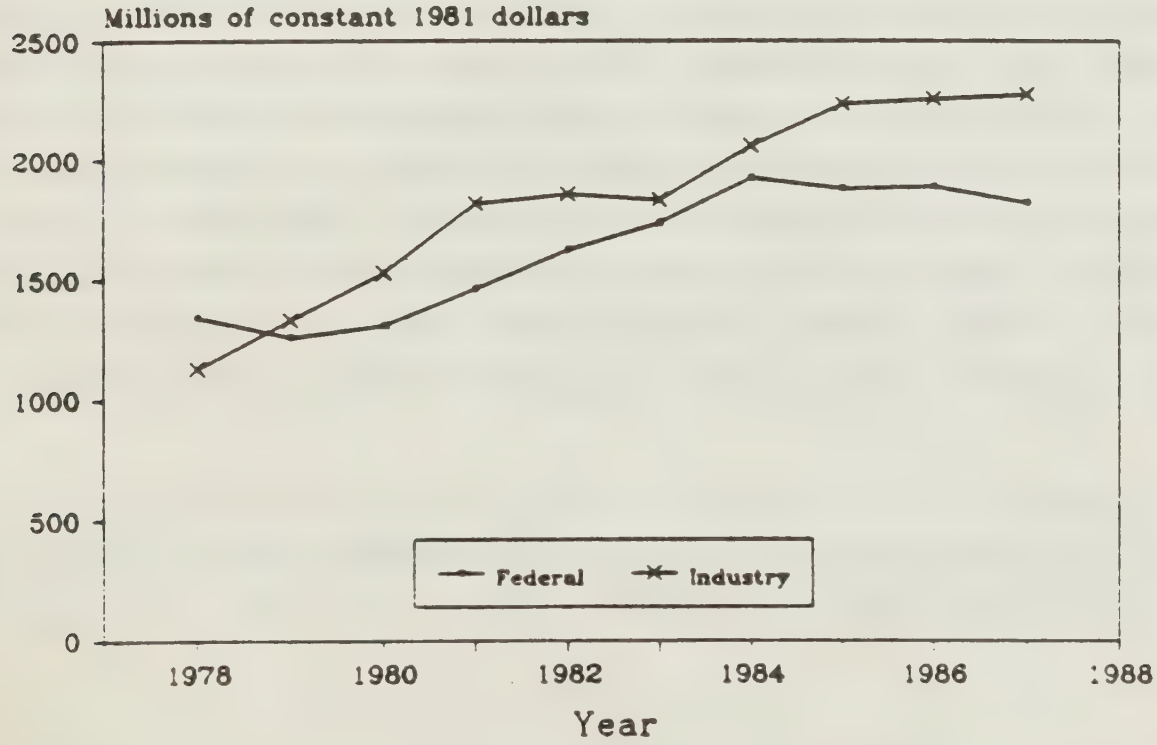
	Canada's rank among eight countries[a]
Gross R&D spending as % of gross domestic product	Lowest
Industry-funded R&D[b]	Lowest
Government-funded R&D[b]	Second lowest
Government-performed R&D[b]	Middle
Higher education R&D[b]	Second lowest
Domestic patents granted[c]	Second lowest
International patents granted[c]	Lowest
Advanced degrees awarded[c]	Middle
Scientists and engineers in labor force[c]	Lowest
Number of technology-intensive industries with positive trade balance	Lowest

a Canada, France, Japan, the Netherlands, Sweden, U.S., U.K., and West Germany. b Adjusted for gross domestic product. c Adjusted for population. Source: National Advisory Board on Science & Technology

Source: "Canada Grapples with Its Science and Technology Policy," Chemical and Engineering News, 6 March 1989.

TABLE 2

R&D FUNDING BY CANADIAN INDUSTRY AND THE GOVERNMENT OF CANADA



Source: Statistics Canada, Science and Technology Indicators, 1987.

In the end, it is probably fair to say that neither the federal government nor industry funds enough R&D in Canada. The scientific indicators certainly verify that Canada's performance is poorer than that of other countries, but industry also ranks low on a list of industrial spending in different countries. The bulk of industrial R&D in Canada is carried out by fewer than 5% of all Canadian companies; approximately three-fourths of the companies in Canada do no R&D at all.(15) These facts must be faced when considering Canada's scientific future. The argument over how much money is spent on R&D, and who spends it, has been ongoing for years. It is, however, only one of many areas under discussion in Canada's science and technology community.

BASIC RESEARCH

Basic research is research performed purely to expand knowledge without any particular practical purpose in view; it is the foundation upon which practical, goal-oriented research is based. A great deal of concern has recently been expressed over the perceived decline in the level of funding for basic research in Canada. Such research, scientists argue, is essential for the future of science in Canada and must be maintained both at the universities and at the National Research Council. But because there is usually no practical use immediately apparent, it is more difficult to get support for this type of research. Over the past few years, the trend has been away from supporting basic, or curiosity-driven, research and towards supporting applied research. This trend has manifested itself in a number of ways. The Natural Sciences and Engineering Research Council (NSERC) provides research funds for university research, which is seen as the main arena for basic research in Canada. NSERC's budget has increased an average of 3.3% per year since 1984; this

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(15) "Canada Grapples with Its Science and Technology Policy," Chemical and Engineering News, 6 March 1989.

barely keeps up with inflation.(16) Although its base budget has been increased, much of the increase has come through a matching funds program, whereby the government matches industry support of university research. A clear advantage to this scheme is that it makes extra dollars available for research; however, some university scientists are concerned that programs of this nature further erode the basic research foundation upon which, they believe, all other research is built.

This trend toward close cooperation with industry is also apparent within the National Research Council, where many new programs are springing up which encourage links between government scientific laboratories and industry.

In many important respects these developments are beneficial for science and technology in Canada. But scientists repeatedly stress the importance of basic research, which they view as the essential base for applied research to build upon.

CENTRES OF EXCELLENCE

In May 1988, the federal government announced that, in direction imitation of the Ontario Centres of Excellence scheme, it had earmarked $240 million to establish a "Networks of Centres of Excellence" program to encourage links between the universities, industry and government. The government plans to establish "collaborative research centres chosen for their excellence, potential for commercial result and ability to establish networks among researchers scattered over the country."(17)

A lengthy review was undertaken by a committee of international and Canadian scientists to choose 14 proposals out of the 158 received by the government. Announced in October 1989, the newly established networks cover a variety of subject areas including research

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(16) "Canada Grapples with Its Science and Technology Policy," Chemical and Engineering News, 6 March 1989.

(17) Nature, Vol. 333, 23 June 1988, p. 722.

into chemical physics, the genetic basis of human diseases, and high performance concrete. A number of institutes have also been formed.(18) Many of the successful proposals have no private sector involvement, reflecting, according to William Winegard, Minister of State (Science and Technology), the government's desire to encourage "pre-competitive" rather than applied research. But the program does help researchers at various institutions in different parts of the country to work together.(19)

The Networks of Centres of Excellence scheme has been praised for injecting much-needed funds into science and technology in Canada. Although critics feared that the program might be used to promote political ends, it appears that projects have been chosen solely on the basis of excellence of researchers and need for the programs. Many hope that the new centres will stimulate the growth of science and technology in Canada.

RESEARCH CONSORTIA

As mentioned earlier, the small amount of money spent on research and development in Canada continues to be a problem. Both government and industry feel that they are contributing as much as possible but Canada still lags far behind other industrialized countries. In an attempt to alleviate this problem, companies are now joining together and cooperating with government and universities to form research consortia, which can work on problems too large for an individual company to tackle alone. It is hoped that the resulting research will allow Canada to become competitive in many emerging scientific and technological areas and to compete in international markets.

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(18) For a complete list of the newly-announced Networks of Centres of Excellence, see Table 3.

(19) "Ottawa Grants Funds for Scientific Research," Globe and Mail (Toronto), 27 October 1989.

TABLE 3

NETWORKS OF CENTRES OF EXCELLENCE

1. research into bacterial diseases in humans, animals, fish and plants;
2. research into the uses of biotechnology to control insect pests;
3. the Canadian Network for Space Research;
4. research into chemical physics;
5. research into the genetic basis of human diseases;
6. research into high-performance concrete;
7. the Institute for Robotics and Intelligent Systems;
8. the Institute for Telecommunications Research;
9. research into microelectronic devices, circuits and systems;
10. research into neural regeneration and functional recovery;
11. the Ocean Production Enhancement Network;
12. research into protein engineering;
13. the Respiratory Health Network of Centres of Excellence; and
14. research into high-value paper production.

Source: "$240 Million Grants Announced to Foster Scientific Research," Toronto Star, 27 October 1989.

The Solid State Optoelectronics Consortium Inc. of Canada is a consortium recently formed by bringing together five large companies working in the field: Alberta Telecommunications Research Centre, Bell Northern Research, Litton Systems Canada Ltd., Microtel Pacific Research and RCA Inc.'s Electro Optics division. The principal mission of the new consortium is to research and develop a prototype that combines optical and electronic functions on a single integrated semiconductor device. This could result in the transmission of data along circuitry based on photons which travel close to 100 times faster than the electrons upon which the current technology is based.

The founding members of the consortium each contribute $250,000 per year and lend three full-time researchers to the consortium. Junior members only contribute $50,000 per year and one researcher. Small businesses have also been asked to join by putting in $10,000 each, annually. The National Research Council is also involved; NRC laboratories will contribute $2 million per year and another $20 million over five years in Division of Physics equipment and staff towards the project. By joining industries and the National Research Council it is hoped that a pool of trained personnel will be built up from which industry can draw when moving from research and development to production.

The various types of members are allowed different access to the technology developed by the consortium. Senior members are allowed immediate access without paying any royalties on patents held by the consortium; junior members must pay royalties; small business members pay royalties and are subjected to a waiting period before obtaining the technology. Businesses that are not members of the consortium are not allowed access to the technology at all.

By bringing together financial contributions from a large number of companies and government, the Solid State Optoelectronics Consortium is able to commit $40 million for research on optoelectronics. Although this is a significant amount of money in Canadian terms, it is only a small fraction of the amounts that are being put forward for research and development in this area by countries such as Japan, the United States and the European Economic Community. Despite this disparity,

those involved in the consortium argue that it is important for Canada to remain in the race to develop this technology and not simply to buy it when it has been developed by other countries. The size of the research effort, they note, does not always determine its outcome.

The high stakes involved in competing in the international marketplace make the formation of research consortia a wise choice for Canadian companies. Questions have been raised, however, about the growing involvement of the main government research agency, the National Research Council. Although the NRC has played a significant role in industrial projects in the past, it is estimated that it will soon have 60% of its work tied up in joint ventures with industrial firms or consortia. By performing more high profile industry research, the NRC hopes to secure more federal financing in the future. But by doing so, however, many argue that the NRC runs the risk of eroding its foundation of basic research. Furthermore, concern has been expressed over a tendency to make university and government laboratories an extension of industry.

Research consortia, however, are undoubtedly good for the growth of research and development in Canada. Another significant consortium, Precarn Associates Inc., was formed to bridge the gap between the developing technology and its utilization by industry. In 1987 a number of companies joined together in this industry-led initiative. Government was approached for financial support but it was difficult to secure such funding as the consortium did not fit into any of the existing programs. By 1989, however, the new Department of Industry, Science and Technology had agreed to a $10 million contribution.

Precarn calls for research proposals from its member companies. Certain of these proposals are selected for funding for a feasibility study, after which the decision is made on which projects will be pursued. Precarn operates slightly differently from the Solid State Optoelectronics Consortium; all members, after paying a flat membership fee, are guaranteed access to information discovered. In fact, the recent agreement with Industry, Science and Technology Canada ensures that all Canadians will have access to the information, although non-members will

have to pay higher royalty fees. There is also a six month publication ban on work, which gives members a period of exclusivity.

The National Research Council is involved through its Industrial Research Assistance Program and Precarn is working on involving the provinces; so far only Alberta and British Columbia have agreed to contribute funds.

HIGH TECHNOLOGY

The federal government is increasingly criticized for its actions in the field of high technology. Trade in goods made using high technology (computers, aerospace equipment, electronics, machinery and drugs) is growing twice as fast as general trade and will soon represent a quarter of all goods traded in the world. These trends underline the important role of high technology in the economic future of industrialized countries.

While the importance of high technology grows, Canada's trade deficit in that area is also increasing; from 1980 to 1987, it grew from $4.6 billion to $7.1 billion. But, although it is recognized that Canada is falling behind in the high technology field, there are many different views on what can be done to improve our position.

Industry tends to blame government for not investing enough money in R&D. But, although they acknowledge that more money is always useful, industry representatives make other suggestions for improving Canada's high-tech track record. They suggest that the government must be responsible for making a climate in which Canadian investors, now wary of long-term investments, will want to put money into advanced technology companies that might show results only many years later. Experts recommend tax incentives be offered to encourage companies to perform research and development. Unfortunately, memories of the Scientific Research Tax Credit scheme, a fiasco which resulted in an estimated loss of $2 billion in tax revenue, make most bureaucrats reluctant to move in that direction again.

But even if R&D tax incentives are not applied, large companies argue that they need, at least, more consistency in the tax scheme in order to plan.

Government strongly refutes the charge that it is not investing enough money in research and development. Indeed, over the past few years it has paid much more attention to science and technology than ever before.

As noted above, however, increases to the science and technology budget have done little to remove Canada from the bottom of the list of an assortment of scientific indicators. Companies that spend a significant amount of money on R&D do reap large benefits, but in high-technology fields, changes occur rapidly so that a company must invest heavily if it is to remain competitive. Unfortunately, few Canadian investors are willing to take long-term risks by investing in R&D, so that more and more high-technology companies in Canada are being bought by foreign owners. In the Ottawa area alone, four high-technology firms have been bought by foreign companies in 1989.

CONCLUSION

The debate over science policy in Canada can at times be very frustrating. Many of the same issues and problems that were discussed 20 years ago are unchanged today, as are many of the scientific indicators denoting the precarious state of science and technology in this country. Today, however, when there is a recognition in Canada and throughout the world that all countries are competing in a global economy, Canada can no longer afford to neglect the growing importance of science and technology and rely on its natural resources. Natural resources will doubtless remain an important component of our national economy, but if it is to remain competitive, Canada must greatly increase the amount of research and development it performs.

Canada has a strong history of excellence in scientific areas - telecommunications, nuclear research and medical research, to name only a few. But in order to continue and to build upon this tradition, a

strong and coherent science policy must be further developed and acted upon. Canada has achieved a great deal in this area in the last few years, but as it moves into the next century, much remains to be done.

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